

## Winter grass cover crop effects on nematodes and yields of double cropped soybean

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### Abstract

Rye (*Secale cereale* L.), wheat (*Triticum aestivum* L.), and annual ryegrass (*Lolium multiflorum* Lam.) are commonly double cropped with soybean (*Glycine max* L.). Recent greenhouse studies have shown variability in plant-parasitic nematode response to cool season grass species and cultivars. However, subsequent soybean performance was not affected by previous annual ryegrass cultivar in the greenhouse. The objective of this research was to determine whether winter cover crop species or cultivars affected nematode populations and subsequent performance of soybean in the field. Four cultivars of annual ryegrass, wheat, and rye, and a fallow control were seeded on a Suffolk sandy loam (fine-loamy, siliceous, thermic Typic Hapudult) soil in each of three years. Nematode-susceptible soybeans were seeded following forage removal. Soil samples for nematode counts were taken immediately before soybean harvest each year. In another experiment, one cultivar each of annual ryegrass, wheat, and rye, and a fallow control were followed by three soybean cultivars selected for differing nematode susceptibility. Grass cultivars did not affect nematode populations under succeeding soybean. The only nematodes affected by grass species in either experiment were *Pratylenchus* spp., *Heterodera glycines* Ichinohe, and *Tylenchorhynchus claytoni* (Kofoid and White) Chitwood. Nematode population means were usually low following ryegrass and high following the fallow control. High soybean yields followed the fallow control, and low soybean yields followed annual ryegrass.

### Introduction

Rye (*Secale cereale* L.), wheat (*Triticum aestivum* L.), and annual ryegrass (*Lolium multiflorum* Lam.) are commonly grown in the winter prior to soybean (*Glycine max* L.) in the Southeastern USA. Such double cropping with wheat was shown to suppress population densities of overwintering *Pratylenchus brachyurus* (Godfrey) Filipjev and Schuurmans-Stekhoven in North Carolina (Koenig *et al.*, 1985) and to reduce numbers of second-state juveniles of

*Heterodera glycines* Ichinohe in Tennessee (Baird and Bernard, 1984). However, these studies were limited to single wheat cultivars, Arthur 71, and Arthur, respectively.

A recent greenhouse study showed variable plant-parasitic nematode populations under several cool-season grass species and cultivars (Pedersen and Rodriguez-Kabana, 1987). A further greenhouse study showed differences in plant-parasitic nematode populations in soybean due to previous annual ryegrass cultivar grown in the same pot. However, soybean often exhibited

low plant-parasitic nematode populations (except for *Heterodera glycines*) compared to soybean following the annual ryegrasses (Pedersen *et al.*, 1988). Soybean dry matter accumulation was not affected by previous annual ryegrass cultivars. It was concluded that the use of an annual ryegrass/soybean double-cropping system may not be effective in controlling most plant-parasitic nematodes in soybean (Pedersen *et al.*, 1988).

Two studies were designed to investigate plant-parasitic nematode population densities in annual grass/soybean double-cropping systems in the field. The objectives of these studies were: 1) to determine whether winter cover crop species or cultivars affect plant-parasitic nematode populations and subsequent performance of a nematode-susceptible soybean in the field, and 2) to determine if winter cover crop species affect plant-parasitic nematode populations and subsequent yield of several soybean cultivars differing in level and type of nematode susceptibility.

## Methods

### Experiment 1

Cultivars were 'Wintergrazer 70', 'AFC 20-20', 'Gurley's Grazer 2000' and 'Northrup King SS 1' rye, 'Marshall', 'Gulf', 'Florida 80', and 'Pen-ploid IV' annual ryegrass, 'Coker 747', Coker 916', 'Omega 78', and 'Florida 301' wheat, and a fallow control. The experiment was a randomized complete block design with thirteen treatments (grass species and cultivars), and eight replications. It was located at the Auburn University Plant Breeding Unit, Tallahassee, AL on a Suffolk sandy loam (fine-loamy, siliceous, thermic Typic Hapudult) soil previously used for soybean production with initial (prior to the experiment) detectable nematode population densities as follows: *Meloidogyne incognita* (Kofoid and White) Chitwood, 38 per 100 cm<sup>3</sup> soil; *Paratrichodorus minor* (Colbran) Siddiqi, 87 per 100 cm<sup>3</sup> soil; *Criconeimoides* spp., 10 per 100 cm<sup>3</sup> soil; *Helicotylenchus dihystra* (Cobb) Sher, 20 per 100 cm<sup>3</sup> soil. The annual grasses

were seeded in a prepared seedbed with a grain drill on 2 December in 1983, 12 December 1984, 5 December 1985, and 9 January 1987. Seeding rates were 100 kg per ha for rye and wheat, and 28 kg per ha for ryegrass. Fertilizer was applied according to soil test recommendations, and nitrogen was applied to all plots at 112 kg per ha immediately preceding seeding, and again in February of each year. Plots were 6.1 × 7.6 m. Forage yields were determined by harvesting a 0.8 × 6.1 m area from the center of each plot with a flail harvester on 15 April and 14 May 1984, 4 April and 14 May 1985, and 7 and 28 April 1987. Due to drought, no data are reported for 1986.

Following the final forage harvest each year, the plots were tilled, and a soybean with no known nematode resistance, 'Ransom' (Weaver *et al.*, 1988), was seeded in eight 0.91 m-wide rows in each plot. Weeds were controlled with a preplant incorporation of 0.42 kg trifluralin (-trifluro-2, -6-dinitro-*N, N*-dipropyl-*p*-toluidine) ha<sup>-1</sup> and 1.47 kg vernolate (*S*-propylidpropylthiocarbamate) ha<sup>-1</sup>. Soybean seeding dates were 14 May 1984, 27 May 1985, 3 July 1986 and 19 May 1987. Due to a lack of seed availability, 'Davis', exhibiting similar nematode reactions (Hartwig *et al.*, 1975), was substituted for Ransom in 1987.

Soil samples for nematode counts were taken immediately before soybean harvest each year, and consisted of a bulk of approximately 20 2.5-cm-diameter soil cores extracted to a depth of 25 cm from the center rows of each plot using a soil probe. Nematodes in these samples were counted using the method described by Rodriguez-Kabana and Pope (1981). The two center rows were harvested and threshed to determine soybean yields on 14, 27, and 14 October in 1984, 1985, and 1987, respectively. As above, no data are reported for 1986 because of drought. Treatments were assigned to the same physical location for the duration of the experiment.

The data were subjected to statistical analysis using the general linear model (GLM) procedure of SAS (SAS, 1985). Grass species were considered as main effects, and grass cultivars were considered to be nested within their respective species.

## Experiment 2

Wintergrazer 70 rye, Marshall annual ryegrass, Coker 916 wheat, and a fallow control were seeded before each of three soybean cultivars selected for a range of nematode susceptibility. Ransom was selected for broad nematode susceptibility. 'Braxton' for resistance to *Meloidogyne incognita*, but susceptibility to *Heterodera glycines* and 'Kirby' for resistance to *Meloidogyne incognita* and *Heterodera glycines* race 3 (Weaver *et al.*, 1988). As above, Davis was substituted for Ransom in 1987. The experiment was designed as a randomized complete block with eight replications. The site, cultural, and experimental practices were the same as for Experiment 1, with the following exceptions. The annual grasses were seeded on 13 January 1987, and the soybeans were harvested on 2 November 1987. The data were analyzed as a factorial design using the GLM procedure of SAS (SAS, 1985).

## Results

### Experiment 1

Grass species effects on *Pratylenchus* spp. and *Tylenchorhynchus claytoni* Steiner population densities under succeeding soybean were significant ( $P \leq 0.05$ ) in 1984 and 1985 (Table 1). Mean soil population densities were low following annual ryegrass for *Pratylenchus* spp. and *Tylenchorhynchus claytoni* in both years. Mean soil population densities of *Pratylenchus* spp. were high following the fallow control. *Heterodera glycines* was not detected in the samples in 1984 and 1985. In 1987, *Heterodera glycines* was detected, and grass species effects were significant ( $P \leq 0.05$ ). High *Heterodera glycines* population densities were found following the fallow control, and low ones following annual ryegrass. No other nematode population densities were affected ( $P \leq 0.05$ ) by grass species. In no instance did grass cultivars affect ( $P \leq 0.05$ ) nematode population densities in the field.

Grass species effects on soybean yields were significant at  $P = 0.06$  in 1984 and  $P = 0.05$  in

1987. In both years, low soybean yields followed annual ryegrass, and high soybean yields followed the fallow control. Grass cultivar effects on soybean yields were significant only in 1987.

### Experiment 2

Soybean cultivar did not affect ( $P \leq 0.05$ ) nematode population densities in 1984 or 1985. In 1987, soybean cultivar effects were significant ( $P \leq 0.05$ ) only for *Heterodera glycines*, with the *Heterodera glycines*-resistant cultivar Kirby, having low *Heterodera glycines* population densities (3.0 per 100 cm<sup>3</sup>), and Braxton and Davis having population densities of 43.8 and 21.7 per 100 cm<sup>3</sup>, respectively. Grass species effects were significant ( $P \leq 0.05$ ) only for *Helicotylenchus dihystera* population densities in 1984 (Table 1).

Soybean cultivar did not affect yield ( $P \leq 0.05$ ) in any of the three years. However, grass species effects were significant for soybean yield in 1985 and 1987 ( $P \leq 0.05$ ), and in 1984 ( $P = 0.07$ ). Soybean yields were low following annual ryegrass in 1984 and 1985, and high following the fallow control in all three years.

No soybean  $\times$  grass interactions were present ( $P \leq 0.05$ ) in Experiment 2.

## Discussion

In this field, rye, wheat, and annual ryegrass cultivars (within species) did not affect nematode population densities in succeeding soybean. Generally, grass species did not affect nematode population densities either. In the few instances that grass species effects were significant, nematode population density means were usually low following annual ryegrass and high following the fallow control.

The only nematodes that were affected by grass species in either experiment were *Pratylenchus* spp., *Helicotylenchus dihystera*, and *Tylenchorhynchus claytoni*. None of these are considered a common problem in soybean production in this region.

In the second experiment, soybean cultivar effects on nematode population densities were significant only for *Heterodera glycines* in 1987.

Table 1. Nematode counts (number/100 cm<sup>3</sup>) and yield of soybean<sup>a</sup> (kg ha<sup>-1</sup>) grown in rotation with rye, wheat, and ryegrass in 1984, 1985, and 1987

Species	<i>Meloidogyne incognita</i>	<i>Heterodera glycines</i>	<i>Pratylenchus</i> spp.	<i>Paratrichodorus minor</i>	<i>Tylenchorhynchus claytoni</i>	<i>Helicotylenchus dihystera</i>	<i>Hoplolaimus galeatus</i>	Soybean yield
<b>Experiment 1</b>								
<b>1984</b>								
Rye	17.5	0.0	8.6	20.6	5.4	13.1	29.7	3560
Wheat	16.8	0.0	6.2	24.7	2.1	20.5	36.4	3600
Ryegrass	20.7	0.0	3.5	15.8	1.2	18.2	28.7	3320
Fallow	19.8	0.0	11.8	22.6	3.6	1.6	4.6	3730
Prob F	0.93	—	0.05	0.29	0.01	0.32	0.50	0.06
<b>1985</b>								
Rye	12.7	0.0	6.2	30.9	2.1	12.6	47.0	2820
Wheat	8.6	0.0	3.6	27.2	2.8	10.3	49.6	2780
Ryegrass	10.6	0.0	1.0	25.8	1.6	10.4	44.3	2820
Fallow	3.0	0.0	18.5	23.3	8.3	20.0	19.8	3400
Prob F	0.51	—	0.01	0.28	0.0	0.62	0.26	0.11
<b>1987</b>								
Rye	34.5	39.1	1.8	12.8	0.0	3.0	7.7	1880
Wheat	44.8	17.4	8.8	12.7	0.0	8.2	12.3	1920
Ryegrass	53.1	12.3	10.1	7.3	0.0	1.8	9.8	1810
Fallow	99.0	48.0	11.0	14.8	0.0	6.5	10.3	2620
Prob F	0.67	0.04	0.44	0.62	—	0.22	0.46	0.05
<b>Experiment 2</b>								
<b>1984</b>								
Rye	7.1	0.0	11.4	10.7	0.7	20.6	27.7	3320
Wheat	13.6	0.0	8.4	10.1	3.4	12.3	29.6	3100
Ryegrass	12.4	0.0	6.9	9.4	0.2	11.4	19.8	2500
Fallow	12.0	0.0	6.4	9.8	1.2	9.2	17.1	3190
Prob F	0.81	—	0.42	0.99	0.20	0.05	0.08	0.07
<b>1985</b>								
Rye	11.4	0.0	26.9	21.8	1.8	28.5	32.2	2720
Wheat	6.4	0.0	18.9	25.6	2.7	19.1	31.7	2550
Ryegrass	12.8	0.0	24.0	25.3	3.7	44.5	25.8	2090
Fallow	12.6	0.0	30.3	15.4	3.3	49.3	34.7	3060
Prob F	0.39	—	0.37	0.46	0.71	0.54	0.78	0.01
<b>1987</b>								
Rye	32.5	19.6	7.0	20.7	0.0	7.4	2.3	1880
Wheat	34.0	23.4	1.9	19.4	0.0	3.1	1.8	1920
Ryegrass	12.0	3.7	3.2	11.9	0.0	17.2	4.2	2020
Fallow	10.6	43.7	2.9	22.4	0.0	20.3	1.4	2460
Prob F	0.51	0.08	0.29	0.20	—	0.47	0.30	0.01

<sup>a</sup> Ransom soybean in 1984 and 1985, and Davis soybean in 1987.

*Heterodera glycines* population densities were low for Kirby, the resistant cultivar. The lack of soybean cultivar effects on *Meloidogyne incognita* population densities based on their known differences in susceptibility, may be due to generally low numbers of these nematodes throughout the course of these studies and is consistent with previous reports (Kinloch *et al.*, 1985).

Generally, soybean yields were highest following the fallow control. Low soybean yields were at times observed following annual ryegrass. At this site, these observations negate a purported advantage for soybean double cropped with these annual grasses based on nematode reduction. Where differences in nematode population densities under soybean were observed, low population densities followed annual ryegrass and high population densities followed the fallow control. It appears probable that the higher soybean yields following the fallow treatment, and the lower soybean yields following annual ryegrass are not associated with nematodes.

A more plausible explanation would be differences in soil moisture at soybean seeding. Although we have no data to substantiate this explanation, maximum retained soil moisture would be expected in the fallowed plots, and based on the late spring growth of annual ryegrass compared to rye and wheat, minimum retained moisture would be expected following ryegrass.

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